

CLAIMS

1. An exposure method for illuminating a first object with an exposure light beam and exposing a second object with the exposure light beam having passed through a pattern on the first object, the exposure method comprising:

tightly enclosing a space which includes at least a part of an optical path for the exposure light beam; and

filling the tightly enclosed space with a predetermined gas through which the exposure light beam is transmitted, until a gas pressure approximate to a first gas pressure is obtained, by alternately repeating, a plurality of times:

a pressure-reducing step of reducing a pressure of a gas in the tightly enclosed space until a gas pressure approximate to a second gas pressure lower than the first gas pressure is obtained; and

a filling step of supplying the predetermined gas to the tightly enclosed space until an intermediate gas pressure between the first gas pressure and the second gas pressure is obtained.

2. The exposure method according to claim 1, wherein:
the exposure light beam is a light beam having a wavelength of 200 nm to 100 nm, and the predetermined gas is nitrogen gas or rare gas; and

the first gas pressure is within a range of 900 hPa to

1100 hPa, and the second gas pressure is within a range of 50 Pa to 10 kPa.

3. An exposure method for illuminating a first object with an exposure light beam and exposing a second object with the exposure light beam having passed through a pattern on the first object, the exposure method comprising:

tightly enclosing a space which includes at least a part of an optical path for the exposure light beam, the exposure method further comprising:

a first step of substituting the tightly enclosed space with a first gas through which the exposure light beam is transmitted; and

a subsequent second step of substituting the tightly enclosed space with a second gas through which the exposure light beam is transmitted, the second gas being different from the first gas.

4. The exposure method according to claim 3, wherein:
the exposure light beam is a light beam having a wavelength of 200 nm to 100 nm; and

a transmittance of the second gas with respect to the exposure light beam is better than that of the first gas.

5. An exposure apparatus for illuminating a first object with an exposure light beam and exposing a second

object with the exposure light beam having passed through a pattern on the first object, the exposure apparatus comprising:

a gas-tight chamber which tightly encloses a space including at least a part of an optical path for the exposure light beam; and

a gas supply unit which supplies a predetermined gas through which the exposure light beam is transmitted, into the gas-tight chamber, wherein:

the gas supply unit has an impurity-removing filter including a light-absorbing gas-removing filter which removes at least one of oxygen and steam contained in the predetermined gas.

6. The exposure apparatus according to claim 5, wherein:

the impurity-removing filter further includes a dust-collecting filter which removes dust contained in the predetermined gas, and an organic matter-removing filter which removes organic matter contained in the predetermined gas; and

the dust-collecting filter, the organic matter-removing filter, and the light-absorbing gas-removing filter are arranged in this order in a direction of flow of the predetermined gas.

7. The exposure apparatus according to claim 6,
wherein:

the gas supply unit includes a gas feed unit which feeds the predetermined gas into the gas-tight chamber, and a temperature-adjusting mechanism which controls temperature of the predetermined gas; and

the gas feed unit, the impurity-removing filter, and the temperature-adjusting mechanism are arranged in this order in the direction of the flow of the predetermined gas.

8. An exposure apparatus for illuminating a first object with an exposure light beam and exposing a second object with the exposure light beam having passed through a pattern on the first object, the exposure apparatus comprising:

a gas-tight chamber which tightly encloses a space including at least a part of an optical path for the exposure light beam;

a gas supply unit which supplies a predetermined gas through which the exposure light beam is transmitted, into the gas-tight chamber;

a gas concentration-measuring unit which measures a concentration of a predetermined residual gas remaining in the space in the gas-tight chamber; and

an opening/closing mechanism which opens/closes a passage for the gas between the space in the gas-tight

chamber and the gas concentration-measuring unit.

9. The exposure apparatus according to claim 8, wherein the gas concentration-measuring unit measures the concentration of at least one of oxygen and steam.

10. An exposure apparatus for illuminating a first object with an exposure light beam and exposing a second object with the exposure light beam having passed through a pattern on the first object, the exposure apparatus comprising:

a gas-tight chamber which tightly encloses a space including at least a part of an optical path for the exposure light beam;

a gas supply unit which supplies a predetermined gas through which the exposure light beam is transmitted, into the gas-tight chamber;

an openable/closable cutoff valve which is provided in a supply passage for the predetermined gas to be supplied by the gas supply unit; and

a control unit which closes the cutoff valve in case of emergency and in case of maintenance for the exposure apparatus to stop the supply of the predetermined gas to the gas-tight chamber.

11. An exposure apparatus for illuminating a first

object with an exposure light beam and exposing a second object with the exposure light beam having passed through a pattern on the first object, the exposure apparatus comprising:

a gas-tight chamber which tightly encloses a space including at least a part of an optical path for the exposure light beam; and

a gas supply unit which supplies a predetermined gas through which the exposure light beam is transmitted, into the gas-tight chamber until a gas pressure approximate to a first gas pressure is obtained, wherein:

the gas supply unit includes a pressure-reducing mechanism which reduces a gas pressure of a gas in the gas-tight chamber to a second gas pressure that is lower than the first gas pressure, a filling mechanism which fills the gas-tight chamber with the predetermined gas until an intermediate gas pressure between the first gas pressure and the second gas pressure is obtained, and a control unit which controls the pressure-reducing mechanism and the filling mechanism so that the reduction of the gas pressure and the filling with the predetermined gas are repeated a plurality of times.

12. An exposure apparatus for illuminating a first object with an exposure light beam and exposing a second object with the exposure light beam having passed through a

pattern on the first object, the exposure apparatus comprising:

a gas-tight chamber which tightly encloses a space including at least a part of an optical path for the exposure light beam;

a first gas supply unit which supplies a first gas through which the exposure light beam is transmitted, into the gas-tight chamber;

a second gas supply unit which supplies a second gas which is different from the first gas and through which the exposure light beam is transmitted, into the gas-tight chamber; and

an adjusting unit which adjusts amounts of the supply of the gasses to be supplied by the first and second gas supply units.

13. The exposure apparatus according to claim 12, wherein the adjusting unit drives the first gas supply unit to supply the first gas into the gas-tight chamber, and then the adjusting unit drives the second gas supply unit to supply the second gas into the gas-tight chamber.

14. A method for producing a device, comprising the step of transferring a device pattern onto a workpiece by using the exposure method as defined in any one of claims 1 to 4.

15. A method for producing a device, comprising the step of transferring a device pattern onto a workpiece by using the exposure apparatus as defined in any one of claims 5 to 13.

16. A method for producing an exposure apparatus for illuminating a first object with an exposure light beam and exposing a second object with the exposure light beam having passed through a pattern on the first object, the production method comprising assembling, in a predetermined positional relationship:

a gas-tight chamber which tightly encloses a space including at least a part of an optical path for the exposure light beam; and

a gas supply unit which supplies a predetermined gas through which the exposure light beam is transmitted, the gas supply unit having an impurity-removing filter including a light-absorbing gas-removing filter which removes at least one of oxygen and steam contained in the predetermined gas.

17. A method for producing an exposure apparatus for illuminating a first object with an exposure light beam and exposing a second object with the exposure light beam having passed through a pattern on the first object, the production method comprising assembling, in a predetermined positional

relationship:

a gas-tight chamber which tightly encloses a space including at least a part of an optical path for the exposure light beam;

a gas supply unit which supplies a predetermined gas through which the exposure light beam is transmitted;

a gas concentration-measuring unit which measures a concentration of a predetermined residual gas remaining in the space in the gas-tight chamber; and

an opening/closing mechanism which opens/closes a passage for the gas between the space in the gas-tight chamber and the gas concentration-measuring unit.

18. A method for producing an exposure apparatus for illuminating a first object with an exposure light beam and exposing a second object with the exposure light beam having passed through a pattern on the first object, the production method comprising assembling, in a predetermined positional relationship:

a gas-tight chamber which tightly encloses a space including at least a part of an optical path for the exposure light beam;

a gas supply unit which supplies a predetermined gas through which the exposure light beam is transmitted, into the gas-tight chamber;

an openable/closable cutoff valve which is provided in a

supply passage for the predetermined gas to be supplied by the gas supply unit; and

a control unit which closes the cutoff valve in case of emergency and in case of maintenance for the exposure apparatus to stop the supply of the predetermined gas to the gas-tight chamber.

19. A method for producing an exposure apparatus for illuminating a first object with an exposure light beam and exposing a second object with the exposure light beam having passed through a pattern on the first object, the production method comprising assembling, in a predetermined positional relationship:

a gas-tight chamber which tightly encloses a space including at least a part of an optical path for the exposure light beam; and

a gas supply unit which supplies a predetermined gas through which the exposure light beam is transmitted, into the gas-tight unit until a gas pressure approximate to a first gas pressure is obtained, the gas supply unit including a pressure-reducing mechanism which reduces a gas pressure of a gas in the gas-tight chamber to a second gas pressure that is lower than the first gas pressure, a filling mechanism which fills the gas-tight chamber with the predetermined gas until an intermediate gas pressure between the first gas pressure and the second gas pressure is obtained, and a

control unit which controls the pressure-reducing mechanism and the filling mechanism so that the reduction of the gas pressure and the filling with the predetermined gas are repeated a plurality of times.

20. A method for producing an exposure apparatus for illuminating a first object with an exposure light beam and exposing a second object with the exposure light beam having passed through a pattern on the first object, the production method comprising assembling, in a predetermined positional relationship:

a gas-tight chamber which tightly encloses a space including at least a part of an optical path for the exposure light beam;

a first gas supply unit which supplies a first gas through which the exposure light beam is transmitted, into the gas-tight chamber;

a second gas supply unit which supplies a second gas which is different from the first gas and through which the exposure light beam is transmitted, into the gas-tight chamber; and

an adjusting unit which adjusts amounts of the supply of the gasses to be supplied by the first and second gas supply units.

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